Claims

1. A propulsion system suitable for a single-use or a multi-use injection device, said propulsion system comprising a container and a primary source of potential energy for propelling a fluid to be injected with sufficient pressure through an orifice to create a jet enabling subcutaneous or intracutaneous delivery of the fluid, the primary source of potential energy principally in the form of a compressible substance under pressure within the container, whereby said potential energy is substantially compression energy of said compressible substance, wherein said substance is a liquid, solid, or other non-gaseous substance as defined at ambient temperature and pressure.

2. Propulsion system according to claim 1, wherein the compressible substance has a volumetric compressibility (dV/V) at said pressure within the container greater than 1.2 times the volumetric compressibility of water.

3. Propulsion system according to any one of the preceding claims, further comprising a secondary potential energy source adapted to propel the fluid to be injected at a pressure lower the pressure generated by the primary source of potential energy.

4. Propulsion system according to the preceding claim, wherein the secondary potential energy source is a gas, as defined at ambient pressure and temperature, under pressure within the container in a container portion separate from a container portion housing the primary compressible substance, or dissolved in or mixed with the primary compressible substance.

5. Propulsion system according to claim 3, wherein the secondary potential energy source is an elastic member such as a spring , or opposed magnets, compressed in the container.

6. Propulsion system according to any one of the preceding claims, wherein the compressible substance is a visco-elastic liquid, an elastic solid, or soft matter.

7. Propulsion system according to the preceding claim, wherein the compressible substance belongs to the family of polysiloxanes.

8. Propulsion system according to the preceding claim, wherein the solid is vulcanised silicon rubber.

9. Propulsion system according to any one of the preceding claims, wherein the pressure of the compressible substance in the container prior to use exceeds 200 bars.

10. Propulsion system according to any one of the preceding claims, wherein the compressible substance is put under pressure in the container by reducing the volume thereof after being filled with said compressible substance.

11. Propulsion system according to the preceding claim, wherein the volume of compressible substance is reduced by a permanent deformation of a wall of the container.

12. Propulsion system according to claim 10 wherein the volume of compressible substance is reduced by a pressure generating mechanism (125) of the device displacing a piston (112).

13. Propulsion system according to any one of the preceding claims 1-11, further comprising a movable or breakable separating or pressure transmitting member enclosing the compressible substance in the container, the separating or pressure transmitting member being adapted to be released or broken to

enable the compressible substance to transmit pressure to said fluid to be injected.

14. Propulsion system according to claim 13, wherein said separating or pressure transmitting member is in the form of a piston maintained in position prior to use by retaining means.

15. Propulsion system according to claim 14, wherein the retaining means comprise a rod (17, 17', 17", 17"', 17"") retaining the piston (5, 5', 5"") prior to use, in a position where the compressible substance 7 is compressed.

16. Propulsion system according to claim 15, wherein the rod (17, 17"') comprises a rupture zone (19, 19', 19") that is rendered fragile by tempering and/or a cross section reduction or indent enabling liberation of the piston by rupture of the rod in said zone by applying a bending or twisting force.

17. Propulsion system according to claim 15 or 16, wherein the rod (17, 17"') is permanently attached, such as by crimping or welding, to a rear end portion (12, 12"') of the container.

18. Propulsion system according to claim 15, wherein the rod (17', 17", 17"") is attached to the container by means (26, 27, 28, 29, 30, 31) external to rod which may be actuated to liberate the rod from the container.

19. Propulsion system according to anyone of claims 15-18, wherein the rod (5') comprises a first portion (36) subject to the pressure of the compressible substance (8), and a second portion (37) of smaller cross section than the first portion for applying a higher pressure than the pressure in the compressible substance on the fluid to be injected.

20. Propulsion system according to claim 15, wherein the rod comprises a passage (32, 33) to enable filling the container with the compressible substance (7) or by the fluid to be injected (2).

21. Propulsion system according to any one of the preceding claims, wherein the propulsion system forms a unit in which the compressible substance is under pressure, the unit being assemblable to an ampoule or capsule containing the fluid to be injected.

22. Propulsion system according to claim 21, wherein said container comprises a portion for receiving and fixing said ampoule or capsule therein.

23. Propulsion system according to claim 13, wherein the piston (5", 5"') is mounted substantially floatably in the container

24. Propulsion system according to claim 13, wherein the separating or pressure transmitting member is a deformable wall (49, 49', 49", 49"").

25. Propulsion system according to any one of claims 1-12, further comprising retaining means comprising a plug (40, 40', 45, 47, 47') for maintaining the pressure of the compressible substance in the container prior to use by closing an orifice or a passage (16, 44, 44', 44", 44"').

26. Propulsion system according to claim 25, wherein the plug (40, 40', 47, 47') is a mechanical plug that may be displaced to liberate said passage or orifice.

27. Propulsion system according to claim 25, wherein the plug (44) is made of a meltable material such as paraffin or a material that may be decomposed by external solicitation, such as localised heating.

28. Propulsion system according to claim 25, wherein the plug (47') is attached to a movable wall or piston (54) arranged in a container portion (9", 9"") containing the compressible substance such that, prior to use, a small amount of the compressible substance is positioned in a rear portion (60') of the container so as to maintain the piston in a position where the plug (47') blocks the passage (44, 44'").

29. Propulsion system according to claim 28, further comprising means to open the rear portion (60') for reducing pressure in this portion and causing displacement of the piston (44) and the plug (47') towards the rear.

30. Propulsion system according to claim 29, wherein the opening means of the rear portion (60') comprise a rear plug (63) provided with a rupture zone (66).

31. Propulsion system according to claim 29, wherein the opening means of the rear portion (60') comprise a rupture zone (58) in the wall of the container.

32. Propulsion system according to claim 28, wherein the movable piston comprises one or more passages (57) interconnecting the rear portion (60') to the remainder of the container portion containing the compressible substance.

33. A propulsion system suitable for a single use injection device, said propulsion system comprising a container and a source of potential energy for propelling a fluid with sufficient pressure through an orifice to create a jet enabling subcutaneous or intracutaneous delivery of the fluid, wherein the source of potential energy comprises a first compressible substance (7, 7') at a first pressure P1 within the container and at least a second compressible substance (7", 77) at a second pressure P2 lower than P1, whereby said potential energy is substantially compression energy of said substances, said

first substance being a liquid, solid, or other non-gaseous substance as defined at ambient temperature and pressure.

34. Propulsion system according to claim 33, wherein the first compressible substance (7) has the composition and properties of the compressible substance as set forth in any one of claims 2 and 6-8.

35. Propulsion system according to claim 33 or 34, wherein the first compressible substance (7) is enclosed in a first section (8a) of the container by a movable or breakable separating or pressure transmitting member adapted to be released or broken to enable the compressible substances to transmit pressure to said fluid to be injected.

36. Propulsion system according to claim 35, wherein the separating or pressure transmitting member has the features of the separating or pressure transmitting member as set forth in any one of claims 14 to 22.

37. Propulsion system according to any one of claims 33-36, further comprising a movable partition (89) separating a first section (8a) of the container comprising the first compressible substance from a second section (8b) of the container comprising the second compressible substance.

38. Propulsion system according to any one of claims 33-36, wherein a first section (8a) of the container comprising the first compressible substance is separated from a second section (8b) of the container comprising the second compressible substance by a reduced section passage (91) blocked by a plug portion (92) prior to use.

39. Propulsion system according to any one of claims 33-38, wherein the second compressible substance is a liquid or solid substance similar to the first compressible substance.

40. Propulsion system according to any one of claims 33-38, wherein the second compressible substance is a gaseous substance, as defined at ambient temperature and pressure.

41. A single-use hypodermic injection device for subcutaneous or intracutaneous administration of a fluid product to be injected, such as a medicament, a vaccine or another pharmaceutical composition, comprising a propulsion system according to any one of the preceding claims, a fluid product to be injected and a nozzle portion having an orifice.

42. Device according to claim 41, wherein the pressure of the compressible substance is sufficient to produce a jet of fluid attaining supersonic speed.

43. Device according to claims 41 or 42, wherein the fluid product to be injected (2) is contained in a separate ampoule or capsule or rigid cartridge, for mounting in or to the propulsion system.

44. Device according to claim 43, wherein the ampoule, capsule or rigid cartridge includes the nozzle portion (11').

45. Device according to claim 44, wherein the ampoule comprises a flexible or deformable wall fixed to the nozzle portion to contain the fluid to be injected therein.

46. Device according to any one of claims 43-45, wherein the ampoule is inserted into the container and held therein by permanently deformed portions (10') of the container.

47. Device according to claim 41, wherein the container comprises a portion (8, 8' 8", 8"', 8"") containing the liquid to be injected (2) and a portion (9, 9', 9", 9"', 9"") containing the compressible substance.

48. Device according to the preceding claim, wherein the portion (8"') containing the liquid to be injected is arranged inside the portion (9"') containing the compressible substance.

49. Device according to claim 47, wherein the portion (8, 8', 8") containing the liquid to be injected is arranged adjacent portion (9, 9', 9", 9"') containing the compressible substance.

50. Device according to claim 41, wherein the device comprises a compressed or liquefied gas within the same container portion (9"') as the compressible liquid (7).

51. Device according to claim 50, wherein the device comprises a slidable second free piston (55) separating the liquefied or compressed gas from the compressible substance (7).

52. Device according to claim 51, wherein the device comprises a compressed spring (88) instead of liquefied or compressed gas.

53. Device according to claim 41, wherein the container portion containing the liquid to be injected comprises a breakable partition such as a tube (76) that may be broken to actuate the device.

54. Device according to claim 53, wherein the tube is dimensioned to enable the creation of a shock wave resulting from the dynamic pressure of the compressible substance in the container portion containing the liquid to be injected following rupture of the tube.

55. Device according to claim 53 or 54, wherein the container portion containing the liquid to be injected is made of glass.

56. Device according to claim 41, wherein the plug is arranged in the nozzle portion (11, 11').

57. Device according to claim 41, wherein the plug of the propulsion system is arranged such that it blocks a passage (44, 44', 44", 44"') interconnecting a container portion containing the liquid to be injected and a container portion containing the compressible substance.

58. Device according to claim 56 wherein the plug is made of high tensile strength wire.

59. Device according to claim 58 wherein the wire is crimped in a ductile insert (99) of the nozzle portion, and defines the orifice diameter.

60. Device according to any one of preceding claims 41-57, wherein the device is needleless and the pressure of the compressible substance is sufficient to propel the fluid product to be injected during use through the orifice such that a fluid jet, having a velocity sufficient to pierce the skin of a patient, is produced.

61. Device according to any one of preceding claims 41-57, further comprising a skin piercing member (93).

62. Device according to claim 61, wherein the skin piercing member forms said nozzle portion (11") and defines said orifice (16").

63. Device according to claim 61 or 62, wherein the skin piercing member is movable.

64. Device according to claim 63, wherein the skin piercing member is maintained in a retracted position by elastic buffer means (96, 96'), such that a piercing tip (97) thereof is arranged substantially flush or behind an application end (15) of the device.

65. Device according to claim 64, wherein the piercing tip of the skin piercing member is movable beyond said application end upon actuation of the device by means of the pressure exerted by the released compressible substance thereagainst, and is retracted by said elastic buffer means during or after injection as the pressure of the compressible substance drops below the elastic force exerted by the elastic buffer means.

66. Propulsion system according to claim 26 wherein the mechanical plug (40') extends into the orifice of the nozzle portion (11'''), and is adapted to be pulled out of the orifice, from an applicator end facing the patients skin (3).

67. Propulsion system according to claim 26 or 66 wherein the plug (40') is part of a high tensile strength wire.